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# Plants Whose Flowers are Utilized by Adults of *Pepsis grossa* Fabricius (Hymenoptera: Pompilidae) as a Source of Nectar

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*Abstract.*—The spider wasp, *Pepsis grossa* Fabricius is a common species of wasp found in the Chihuahuan Desert. This study was conducted in Big Bend Ranch State Park (Brewster Co., Texas) and reports on flowers of various plant species used by adults of this wasp as a source of nectar. Although nectar was obtained from the flowers from a total of 19 plant species, four of those species (milkweed: *Ascepias texana* and *A. sperryi*; Mexican Buckeye: *Ungadia specisosa*; Honey Mesquite: *Prosopis glaudulosa* ) accounted for 73.6% of all plants utilized. The flowers from these plants were all characterized by short corolla tube lengths (<3.5 mm). At this site, *P. grossa* exhibited a narrow trophic niche breadth (Levin's index: $B = 0.2816$). Other common species of plants whose flowers were not visited by these wasps are also identified.

Tarantula hawk wasps of the genus *Pepsis* (Hymenoptera: Pompilidae: Pepsinae: Pepsini) are large, long-legged wasps, and are conspicuous components of the arthropod fauna of desert regions of the southwestern United States and Mexico (Punzo 1994a, 2000). The genus *Pepsis* is found in North and South America, and the West Indies, ranging from Utah (latitude 42 N) to Argentina (45 S) (Hurd 1952, Vardy 2002). Although females of these wasps typically hunt and paralyze large spiders as a source of food for their carnivorous larvae (Petrunkevitch 1926, Schmidt 2004), the adults are nectivorous (Williams 1956, Punzo 1994b).

Although there have been some studies on the ecology (Cazier and Mortenson 1964, Field 1992, Punzo 2005), territoriality (Alcock 1979, 2000), hunting behavior (Petrunkevitch 1926, Cazier and Mortenson 1964, Punzo and Garman 1989, Punzo 1994b), neurochemistry (Punzo 1990, 1991), venom chemistry (Schmidt 1990, 2004), morphology of venom glands (Schoeters et al. 1997), and physiology (Punzo 1990) of *Pepsis* wasps, there is a paucity of information available on the natural history of many species (Punzo 2005).

These wasps are known to obtain nectar from the flowers of a variety of plants (Evans and West-Eberhard 1970, Punzo 2000). However, little information exists on the specific range of plants utilized by any *Pepsis* wasp (Punzo 2005). In desert regions, where ambient temperatures may exceed 43 C during late spring and summer months, female wasps often fly over considerable distances during daylight hours, searching for a suitable host (Vardy 2002, Punzo 2005). Male wasps engage in energetically costly activities as well, including an aggressive aerial defense of territories against intruders (Alcock and Bailey 1997). Insect flight is energetically costly under any circumstance. Thus, it is essential that adult wasps obtain required nutrients in order to survive and reproduce. In addition, because any specific type of plant tissue or nectar may lack some essential dietary requirement, it is only through careful selection of particular plants that an animal can obtain a balanced diet.

The purpose of this study was to identify the species of plants (flowers) visited by adults of *Pepsis grossa* (Fabricius 1798), formerly described as *Pepsis formosa formosa* (Say), in order to obtain nectar. The study was conducted in Big Bend Ranch State Park located in Trans Pecos Texas.

## DESCRIPTION OF GENERAL STUDY AREA

Big Bend Ranch State Park (BBRSP, Presidio Co., Texas) lies within the northern region of the Chihuahuan Desert. It is bordered to the west by the Rio Grande River (RGR), and climatic conditions range from semi-arid to arid (Parent 1996, Punzo 2000). Mean monthly air temperatures range from 5.1 C in January to 33.4 C in July, with low and high temperatures of −10.7 and 45.6°C, respectively (U.S. Dept. of Interior, 2002). Annual rainfall is typically between 14.6–29.7 cm, depending on location and altitude, with 70–80% occurring from May through October (Medellin-Leal 1992). A wide range of topographic diversity exists within the Park, including igneous rocks, gypsum formations, limestone deposits that provide a variety of substrates including alluvial fans, moutain ridges, canyons, saline playas, gypsum flats, siliceous and gypsum dunes, fine-textured basins, and freshwater seeps and springs (Milford 1991), all supporting a diverse plant fauna with distinct vegetative zones (Powell 1988).

## MATERIALS AND METHODS

I conducted field studies within the BBRSP in 2003, from late March through September, when plants of this region have well developed flowers. The study site was an area located within a 3.0 km radius of Grassy Banks (29°17′30″ N, 103°55′04″ W; elevation: 814 m) which is located directly off State Road 170, 6.76 km NW of Lajitas, Texas. The western edge of the site is bordered by the RGR. The soils along the canyon floor are a mixture of sand, gravel and adobe, and support a predominantly sotol-lechuguilla plant community. The dominant vegetation includes lechuguilla (*Agave lechuguilla*), smooth sotol (*Dasylirion leiophyllum*), ocotillo (*Fouquieria splendens*), mesquites (*Prosopis* spp.), purple sage (*Leucophyllum frutescens*), creosote (*Larrea divaricata*), false agave (*Hechtia texensis*), tarbrush (*Flourensia cernua*), catclaw acacia (*Acacia berlandieri*), prickly pear cacti (*Opuntia* spp.), yuccas (*Yucca* spp.), and scattered clumps of milkweed (*Ascepias sperryi*) and grasses, including chino gramma (*Bouteloua breviseta*), fluffgrass (*Erioneuron pulchellum*), and beargrass (*Nolina erumpens*). Numerous large rocks and boulders are scattered along the canyon floor, and the canyon walls are comprised mainly of sandstone, limestone, and igneous rock.

*Pepsis grossa* (Fabricius) is the most common *Pepsis* wasp at this location (Punzo 2000). Males can be observed in flight either moving between flowers or defending territories, feeding at flowers, or resting on various bushes and plants. Females are readily visible, flying in search of hosts or food plants, or walking rapidly over the ground surface exploring various crevices and burrows for suitable spiders.

Twenty square-shaped transects were established within the study site. The dimension of each transect was 54 $m^2$. With the aid of several field assistants, I walked through each transect in a linear fashion, following paths delineated by small yellow cords placed along the ground in an east-west direction, and separated by a distance of 6 m. Adult wasps were collected using sweep nets. We recorded the following data for each wasp observed and collected: (1) time of collection (Central Standard Time, CST); (2) sex; (3) if feeding, the species of plant (flower) being utilized; (4) type of plant for wasps observed resting on vegetation; (5) for flowers at which wasps were observed feeding, flowers were collected and length of the corolla tube was measured to the

Table 1. Species of plants whose flowers were used as a source of nectar (percent utilization) by adults of *Pepsis grossa* at a study site (Grassy Banks) located within Big Bend Ranch State Park, Brewster Co, Texas, during 2003. Data expressed as percentage utilization of 19 food resources. Data pooled for males ($n$ = 504) and females ($n$ = 488). Scientific and common names of plants based on Powell (1988). $B$ = Levin's measure of trophic niche breadth.

| Plant species | Mean corolla length (mm) (± SE) | Percent utilization |
|---|---|---|
| *Ascepias texana* Torrey (Texas Milkweed) | 3.45 (0.41) | 28.4 |
| *A. sperryi* Woods (Sperry Milkweed) | 3.55 (0.23) | 17.9 |
| *Ungadia speciosa* Endler (Mexican Buckeye) | 2.95 (0.23) | 16.1 |
| *Prosopis glandulosa* Benson (Honey Mesquite) | 3.35 (0.28) | 11.2 |
| *P. pubescens* Gray (Screwbean Mesquite) | 4.29 (0.18) | 3.5 |
| *Lycium pallidum* Correll (Pale Wolfberry) | 5.04 (0.31) | 1.7 |
| *Diospyros texana* Scheele (Texas Persimmon) | 5.23 (2.45) | 3.6 |
| *Agave lechuguilla* Torrey (Lechuguilla) | 6.02 (2.06) | 3.1 |
| *Yucca treculeana* Correll (Spanish Dagger) | 6.78 (3.03) | 3.1 |
| *Y. rostrata* Engelman (Beaked Yucca) | 6.02 (1.87) | 0.6 |
| *Dasylirion texanum* Scheele (Texas Sotol) | 5.75 (1.93) | 1.8 |
| *D. leiophyllum* Engelman (Desert Candle) | 7.25 (2.11) | 0.5 |
| *Opuntia imbricata* Hawes (Cane Cholla) | 7.43 (2.04) | 2.7 |
| *O. schotti* Engelman (Dog Cholla) | 8.02 (2.18) | 1.6 |
| *O. phaeacantha* Engelman (Purple-fruited Pricklypear) | 7.47 (1.99) | 0.6 |
| *Salvia greggi* Gray (Autumn Sage) | 4.48 (0.32) | 1.8 |
| *Forestiera angustifolia* Torrey (Desert Olive) | 8.04 (1.97) | 1.1 |
| *Nolina erumpens* Torrey (Bear grass) | 4.88 (0.67) | 0.3 |
| *Senecio douglasii* Benson (Groundsel) | 7.79 (1.08) | 0.1 |
| | | $B$ = 0.2816 |

nearest mm using a portable Unitron dissecting microscope fitted with an ocular measuring grid; (5) species of plants where wasps were not observed to visit flowers. Only those wasps that extended their tongues into the corolla, or that were observed to enter the corolla tube of flowers with their entire head capsules (and in some cases, part of the thorax as well) and remain there for at least 20 sec were considered to be in the act of feeding. Each of these wasps was collected, frozen on dry ice, and taken back to the laboratory to confirm feeding by dissecting the gut and analyzing gut contents.

Trophic niche breadth was determined using the standarized Levin's index ($B$) (Levins 1968): $B = 1/\sum p_j^2$, where $p_j$ represents the proportion of individuals (percent utilization) found on a particular resource (plant species–flower). Values for this measure can range from 0 (narrowest trophic niche: all resources fall under one resource category) to 1.0 (resources represented equally in all categories).

## RESULTS AND DISCUSSION

During daylight hours, male and female wasps were observed resting on shaded areas of leaves or branches of cottonwood (*Populus fremontii*), willows (*Salix taxifolia* and *S. interior*), walnut (*Juglans microcarpa*), oak (*Quercus oblongifolia*), mesquite (*Prosopis pubescens* and *P. glandulosa*), persimmon (*Diospyros texana*), milkweed (*Ascepias speciosa* and *A. speryii*), Mexican buckeye (*Ugnadia speciosa*), leatherstem (*Jatropha dioca*), and soapberry (*Sapindus saponaria*). These same trees were used as perch sites by males during April and May, when activities associated with territorial defense and breeding are most intense (Cazier and Mortenson 1964, Punzo 2000, 2005).

The species of plants whose flowers were used as a source of nectar by adults of *P. grossa* are listed in Table 1. This represents the first detailed list of specific food plants for a wasp in this genus. Because no significant differences were found between males ($n$ = 504) and

Table 2. Species of plants common at the Grassy Banks study site in Big Bend Ranch State Park whose flowers were not observed to be visited and used as sources of nectar by adult males or females of *Pepsis grossa* as sources of nectar. Scientific and common names of plants based on Powell (1988). Data on corolla tube length (mm) expressed as means (± SE); N = number of each plant species.

| Species | N | Corolla tube length (mm) |
|---|---|---|
| *Aloysia gratissima* Tronc. (Whitebrush) | 617 | 10.05 (1.74) |
| *Amsonia longiflora* Torr. (Bluestar) | 448 | 9.02 (1.87) |
| *Cowania ericifolia* Torr. (Heath Cliff Rose) | 194 | 7.79 (1.21) |
| *Croton doicus* Cav. (Grassland Croton) | 847 | 5.81 (0.44) |
| *Euphorbia antisyphilitica* Zucc. (Candelilla) | 524 | 5.06 (1.12) |
| *Fallugia paradoxa* Endl. (Apache Plume) | 456 | 8.05 (1.89) |
| *Fouquieria splendens* Engelm. (Ocotillo) | 905 | 13.84 (4.02) |
| *Hibiscus coulteri* Harv. (Desert Rosemallow) | 389 | 7.52 (1.09) |
| *Justica warnockii* Turner (Warnock Justica) | 197 | 5.94 (0.68) |
| *Krameria glandulosa* Torr. (Range Krameria) | 295 | 4.35 (0.38) |
| *Lantana macropoda* Torr. (Vinylleaf Lantane) | 428 | 13.21 (2.05) |
| *Mendora longiflora* Gray (Showy Mendora) | 236 | 14.56 (2.77) |
| *Leucophyllum frutescens* Berl. (Purple Sage) | 683 | 11.93 (2.97) |
| *Selinocarpus parvifolias* Standl. (Little Moonpod) | 379 | 16.84 (5.25) |
| *Senna wislizenii* Gray (Senna) | 257 | 4.76 (0.46) |

females ($n$ = 488) (Chi square test: $X^2$ = 1.06, $P > 0.06$), data in Table 1 are pooled for both sexes. Results indicate that at this study site, adults of *P. grossa* utilize the flowers of 4 out of 19 plant species considerably more frequently than the others, which is also reflected in the value obtained for Levin's index. It should also be pointed out that flowers of the most frequently used species have the shortest corolla lengths. These four species accounted for 73.6% of the plants whose flowers provided these wasps with nectar.

In contrast, wasps were never observed feeding from the flowers of other plant species that were commonly found at this site (Table 2). Ten of these 15 species have flowers whose corolla lengths are in excess of 7 mm, and 6 have values greater than 10 mm. In view of this, as well as from the data in Table 1 on the four most-utilized plant species, these results suggest that adults of *P. grossa* prefer flowers with short corolla lengths. However, a number of species listed in Table 1 and 2, with corolla lengths less than 6 mm, were visited infrequently or not at all by these wasps, suggesting that other properties, in addition to corolla length, may influence suitability of flowers as a food source.

According to a few previous reports, *Pepsis* wasps from the southwestern United States have been observed visiting the flowers of a number of families of suffrutescent and woody flowering plants (Lincecum 1867, Hurd 1948), although no systematic attempt was made to identify the species of possible food source plants. Lincecum (1867) was the first to observe an apparent preference of these wasps for flowers of milkweed plants of the genus *Ascepias*, which is in agreement with the results of this study. In addition, these wasps play an important role in the pollination of milkweed plants (Hurd 1948).

In conclusion, the relatively narrow trophic niche breadth exhibited by adults of *P. grossa*, coupled with the fact that flowers from all of the plants listed in Tables 1 and 2 are common throughout the spring and early summer at this study site, indicates a preference for the flowers of *Asclepias* species and *Prosopis glandulosa*. It is interesting to note that flowers of another mesquite species, *P. pubescens*, are visited far less frequently than those of *P.*

*glandulosa*, even though these plants are often found in close proximity. These wasps may be using species-specific visual, olfactory and/or gustatory cues to make decisions as to which flowers to feed on. Other species of nectivorous insects, including various species of butterflies and bees, are known to use combinations of these types of cues to choose sources of nectar (Heinrich 1979, Stone 1994).

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